Aerosol Single Scattering Albedo in Mexico City

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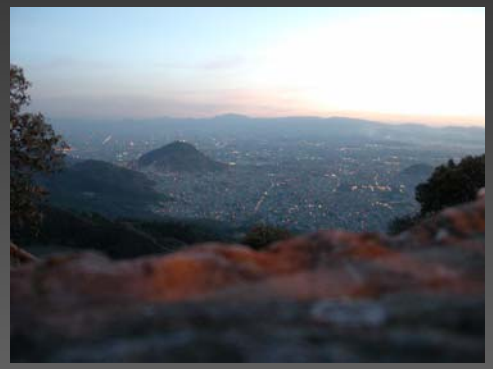
Abstract

Aerosol single scattering albedo (SSA) values are calculated as the ratio of scattering to total extinction (scattering plus absorption). SSA is a fundamental parameter to establish the effect of aerosol on the planetary radiative balance and therefore to estimate aerosol effects on climate. Optically absorbing aerosol (SSA<<1) may contribute to atmospheric warming while cooling the earth surface, while scattering aerosol (SSA~1) may counteract greenhouses gases warming effect by reflecting sun-light in the atmosphere and interacting with clouds. As part of the multi-national multi-institution effort to measure megacities pollution emissions effects on the atmosphere and climate (MIRAGE), we measured ensemble aerosol absorption and angle-integrated scattering data during a field campaign in Mexico City (MILAGRO March 2006). The measurements were performed using an aerosol photoacoustic spectrometer with an integrated nephelometer (PAS) operating at 781 nm. The PAS was mounted on-board the Aerodyne inc. mobile laboratory which hosted a wide variety of other gases and aerosol instruments. During the campaign the van was moved in different locations to capture pollution dependencies on location, aging, elevation, sources etc. We report here a preliminary analysis of SSA values at 781 nm. SSA day-by-day variations as hourly variations will be presented for different locations and discussed in the poster.



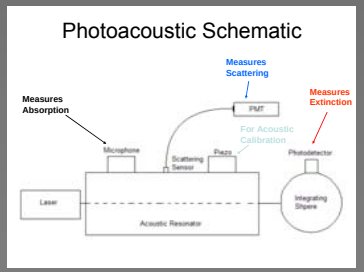
Mexico City from the Pico Tres Padres

Change in visibility

The Instrument

The LAPA instrument (Droplet Measurement Technology, Inc. Boulder, CO) was installed on board the Aerodyne Inc. Mobile Laboratory. The instrument measured simultaneously aerosol absorption and ~180 integrated scattering at 781nm [Arnott et al. 1999, 2000, 2003]. The mobile laboratory carried other instrumentation that measured microphysical and chemical properties of aerosols and clouds. Absorption and scattering calibration of the instrument was carried out in the laboratory using a kerosene lamp and smoldering wood smoke.

In the LAPA instrument, laser light that has been modulated to the resonance frequency of the spectrometer enters the acoustic resonator and comes in contact with the gas inside. When the laser light hits the gas or aerosol, it is absorbed and converted to an acoustic pressure wave through gas expansion. The microphone can detect this sound signal and make a measurement of light absorption. The Piezoelectric disk allows for the finding of the acoustic resonance frequency and the gain of the spectrometer, and is used for calibration.



Photoacoustic schematic:

- **Microphone for acoustic signal measurement. Absorption**
- **Integrating sphere for extinction measurement**
- **Lambertian diffuser for scattering measurement**

Definition of Aerosol Single Scattering Albedo

$$\omega = \frac{K_s}{K_a + K_s}$$

Where Ka is the absorption coefficient and Ks is the scattering coefficient.

Analysis of SSA in Mexico City

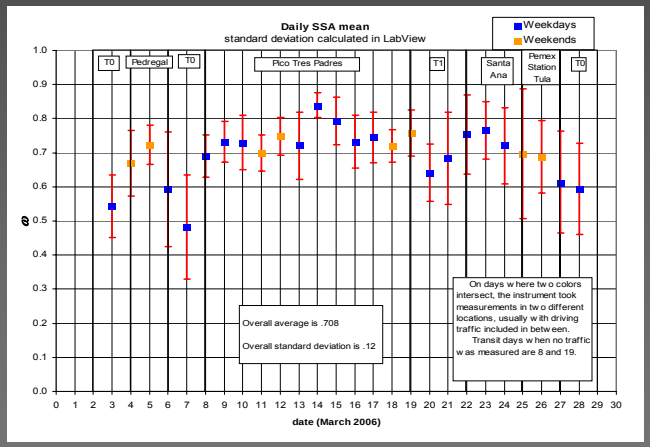
The single scattering albedo of aerosols is one of the parameters used to calculate aerosol forcing as demonstrated in the equations below. SSA is represented by ω.

$$\Delta F_R = -\frac{S_0}{4} T_{atm}^2 (1-N)\left[(1-a)^2 2\beta\tau_{sc} - 4a\tau_{abs}\right]$$

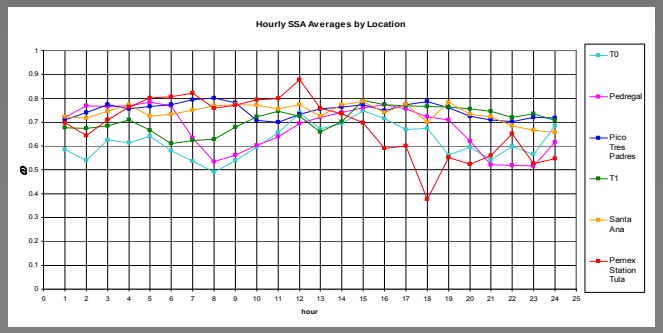
Where

$$A = 2\tau(1-\omega) = 2\tau_{abs}$$

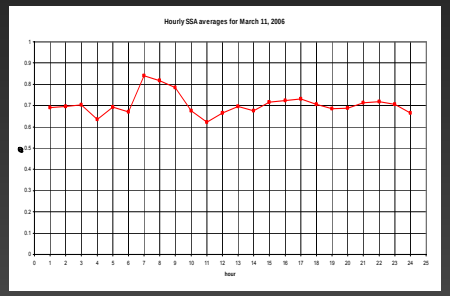
During the field campaign the aerosol single scattering albedo (SSA) measurements ranged between about 0.5 and 0.9, with an overall average of 0.71. High SSA values indicate either high scattering values or low absorption values. We report here a preliminary analysis of single scattering albedo measurements.



Graph displaying daily Single Scattering Albedo averages, sorted by location.



Graph displaying hourly averages of Single Scattering Albedo, identified by location.



Graph displaying the hourly averages for one day, March 11, 2006, at Pico Tres Padres. Note the morning peak, possibly due to a morning commute to work.

Some General Conclusions:

The overall average of single scattering albedo in Mexico City from March 3-28 is .71, with a calculated standard deviation of .12. This number doesn't discriminate between location or time of day.

The site at T0 seems to have the lowest SSA values, while the highest occur at Pico Tres Padres.

Pedregal and T0 share similar shapes by the hour, both peaking in the morning, dropping way down, peaking again in the early afternoon, dropping again but slower, and rising at the end of the day.

Santa Ana stayed relatively level all day, while at Pemex Station Tula, there was a drastic peak at noon and a reversed peak around 6:00 pm.

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